N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM MICROFICHE. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE

July 1981

(NASA-CR-164639) PROTOTYPE Ge:Ga DETECTORS FOR THE NASA-AMES COOLED GRATING SPECTROMETER Final Technical Report, 1 May 1980 - 31 Jan. 1981 (Cornell Univ., Ithaca, N. Y.) 12 p HC A02/MF A01 CSCL 14B G3/35

N81-28419

Unclas 27053

CORNELL UNIVERSITY

Center for Radiophysics and Space Research

ITHACA, N. Y.

FINAL TECHNICAL REPORT

for

NASA-Ames Research Center

on

Cooperative Agreement NCC 2-79

PROTOTYPE Ge:Ga DETECTORS FOR THE NASA-AMES COOLED GRATING SPECTROMETER

May 1, 1980 - January 31, 1981

Principal Investigator: J. R. Houck

CENTER FOR RADIOPHYSICS AND SPACE RESEARCH
CORNELL UNIVERSITY
ITHACA, NEW YORK 14853

FINAL TECHNICAL REPORT

of

"PROTOTYPE Ge:Ga DETECTORS FOR THE NASA-AMES COOLED GRATING SPECTROMETER"

NASA-Ames
Cooperative Agreement
NCC 2-79

May 1, 1980 - January 31, 1981

Principal Investigator: J. R. Houck

I. INTRODUCTION:

Techniques for the routine fabrication of Ge:GA detectors were developed under this grant. Numerous detectors were fabricated and tested including seven elements mounted in cavities supplied by E. Erickson of NASA-Ames.

In addition to the usual infrared measurements of responsivity and noise, measurements were made of the detectors response to ionizing radiation. These results are attached as an appendix.

II. DETECTOR PREPARATION:

A. Material:

The detectors were fabricated from a Ge:Ga wafer from Eagle-Pitcher with a room temperature resistivity of $\sim 12\Omega$ cm. The wafer is approximately 2" in diameter and 0.061" thick.

B. Contacts:

The material was ion-implanted with Boron using 10^{14} ions/cm^2 at 25 Kev and 2×10^{14} ions/cm^2 at 50 Kev. The crystal was then sputter-cleaned and metalized first with sputtered Ti and then sputter Au.

C. Detector Chips:

The 2×2mm detector chips were cut using an abrasive saw. To remove saw damage the contacts were temporarily protected by a wax film and the sawn surfaces etched with CP-4. The chips were then indium-soldered into the detector cavities.

III. Detector performance:

Once the fabrication techniques were standardized, highly uniform detectors could be quickly produced. Typically, parameters from one detector to the next varied by ±10%. In general the characteristics are as follows:

R_I (^{amp}/watt)	$\sim$ 4.0†	(DC)^{x}
V_N (R_L = 5E9)	$\sim$ 7.5 μv*	
V_{BIAS}	$\sim$ 0.2 v	

†Averaged from 40 to 100 μm.

^{x}One can expect to achieve about 75% of the above responsivity at $20H_z$.

*Background power of 5E-11 watts.

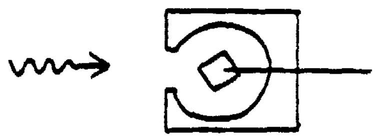
APPENDIX

TEST CONDITIONS

(1) Detector: Ge:Ga $2\times 2\times 1\frac{1}{2}$ mm

Eagle-Picher; LC 1606 with ion implanted contacts.

(2) Cavity: Gold-plated copper 6 mm $\phi\times 1\frac{3}{4}$ mm deep entrance hole 1.34 (mm^2)



(3) Led: Standard red led with heat sink

Typical operation 0.5 ma
No detectable heat up at this current

(4) Optical System: OPI (see next two pages)

Signal power levels:

Low level: 1.5×10^{-13} w in band (with 2% filter)

High level: 5×10^{-11} w in band

Dark (slide closed $P_B << 10^{-14}$ w

(5) Signal Source: Chopped LN_2 "Black Body"

(6) Electronics:

Eltec load resistor

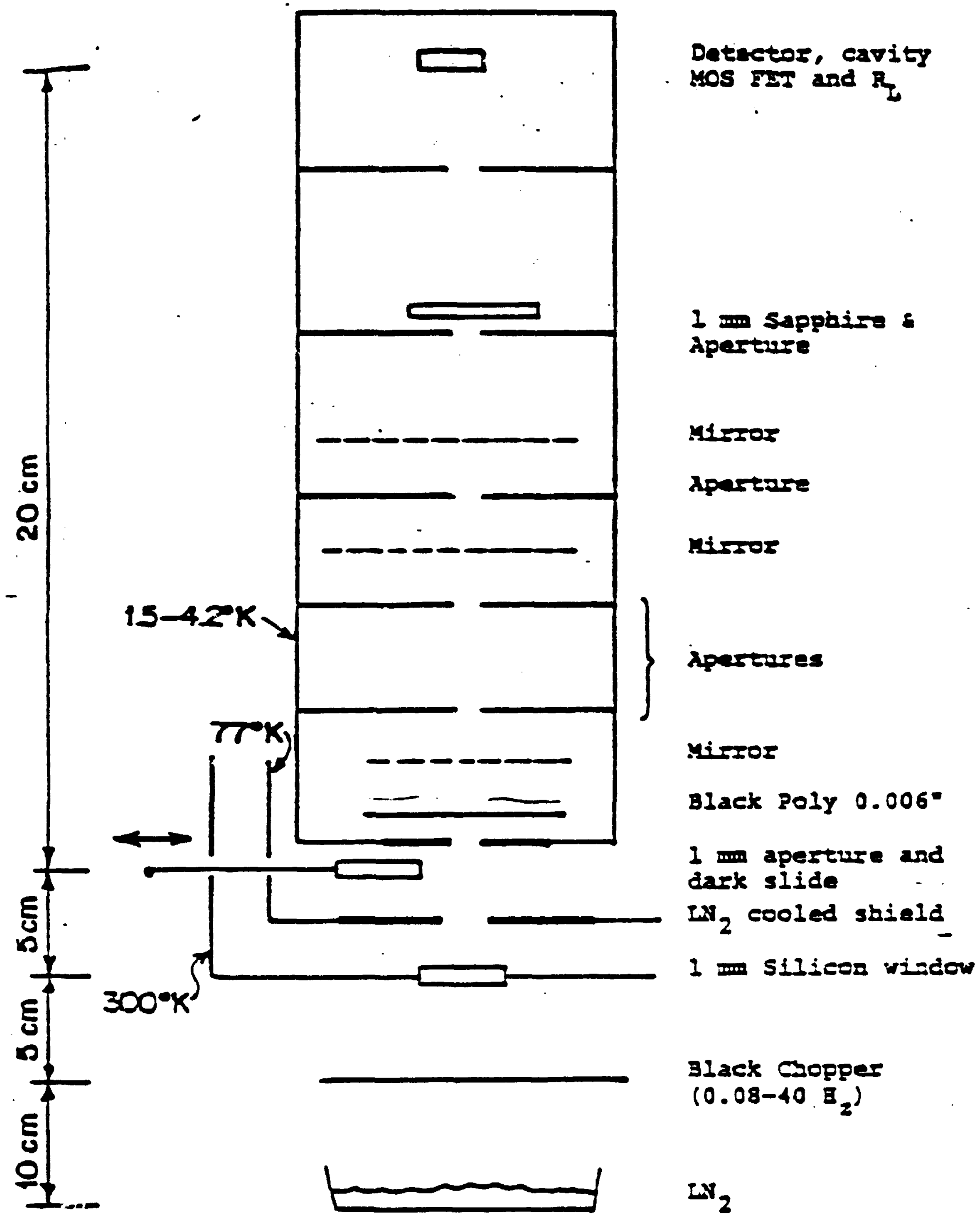
$R(2°K) = 5\times 10^3\ \Omega$

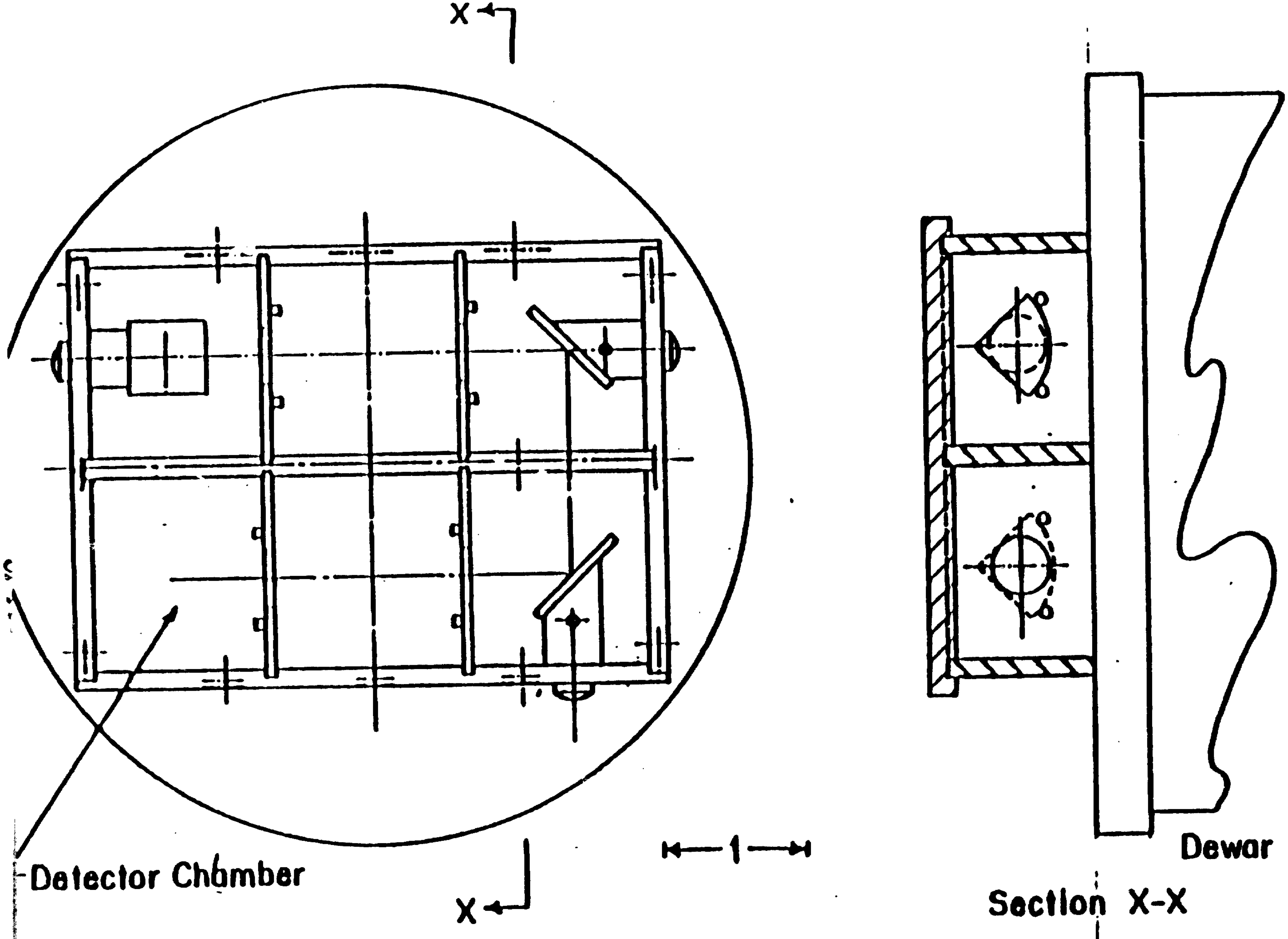
Standard TIA with

Balanced JFET ($\sim$100°K) 2N6484

OPTICAL PATH ("unfolded) OPI

CORNELL FILTERS




X
X
Detector Chamber
1
Dewar
Section X-X

TEST RESULTS

(1) <u>Responsivity vs. LED-Induced Background:</u>

The AC (20 H_z) and DC responsivities increased by 20x for a LED-induced photo current of 1.4×10^{-9} Amps (V_B = 250 mv) (The DC responsivity changed by less than 30% for an IR-induced photo current of the same magnitude.)

(2) <u>Recovery Time:</u>

The recovery time (the time required for the excess (LED induced) responsivity to decay to $^1/e$) depends on many factors. These include temperature, IR background and bias voltage.

Test No.	T (Recovery)	Condition
1	∿36 minutes	Dark $P_B << 10^{-14}$w
2	"	Very low bkg; $P_B \sim 1.5\times10^{-14}$w
3	"	Low bkg; $P_B \sim 1.5\times10^{-13}$w
4	6.1 minutes	High bkg; $P_B \sim 5\times10^{-11}$w (Reduced bias 105 mv)
5	4 minutes	High bkg; $P_B \sim 5\times10^{-11}$w (Normal bias 200 mv)
6	6.3 minutes	Low bkg; 1.5×10^{-13}w 3.1°K
7	∿20 sec	V_B = 1.0 v - full breakdown

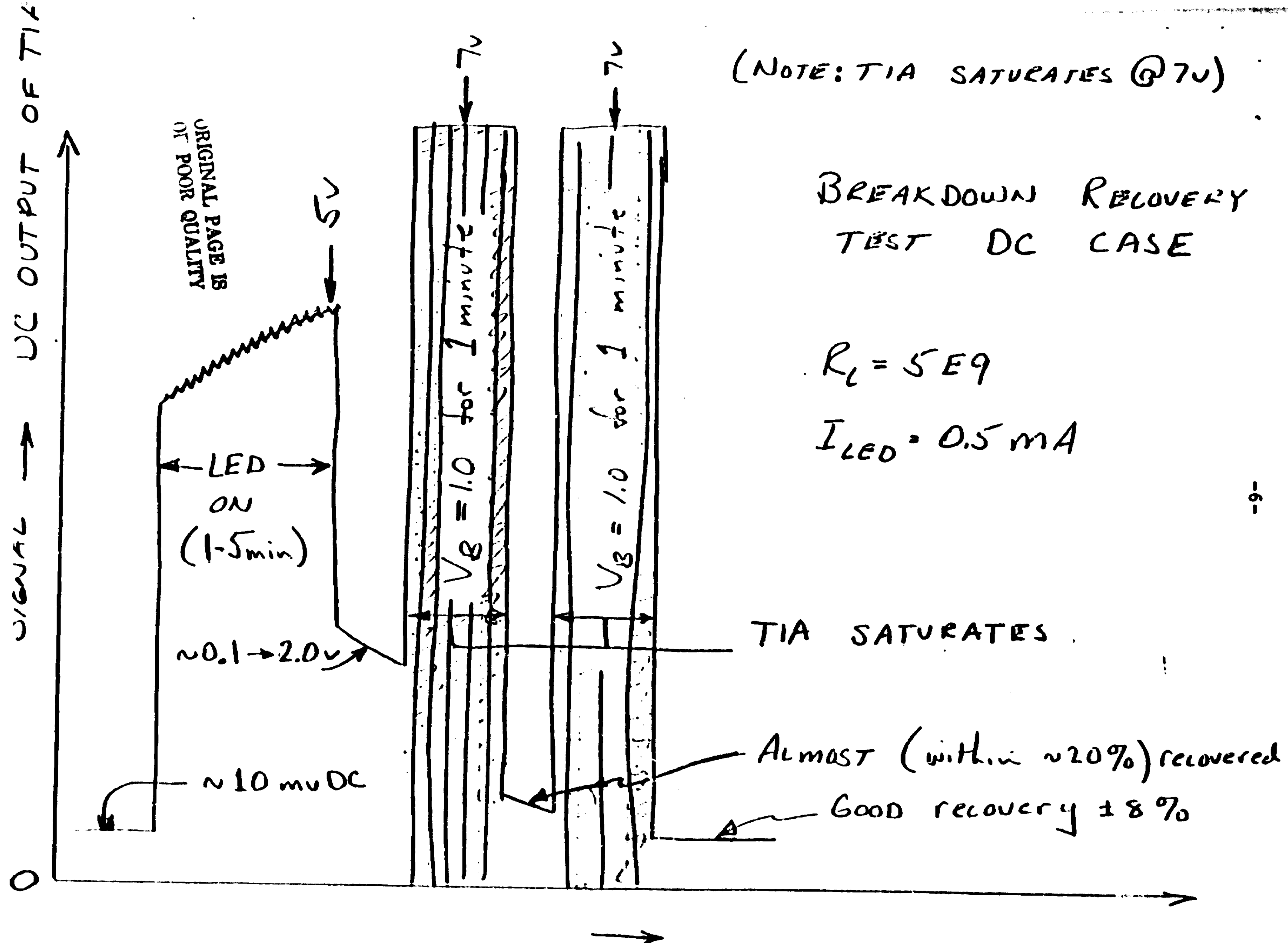
Tests 1,2,3,4,5 and 7: $T_{DET.} \gtrsim 1.7$°K (T_{BATH} = 1.6°K)

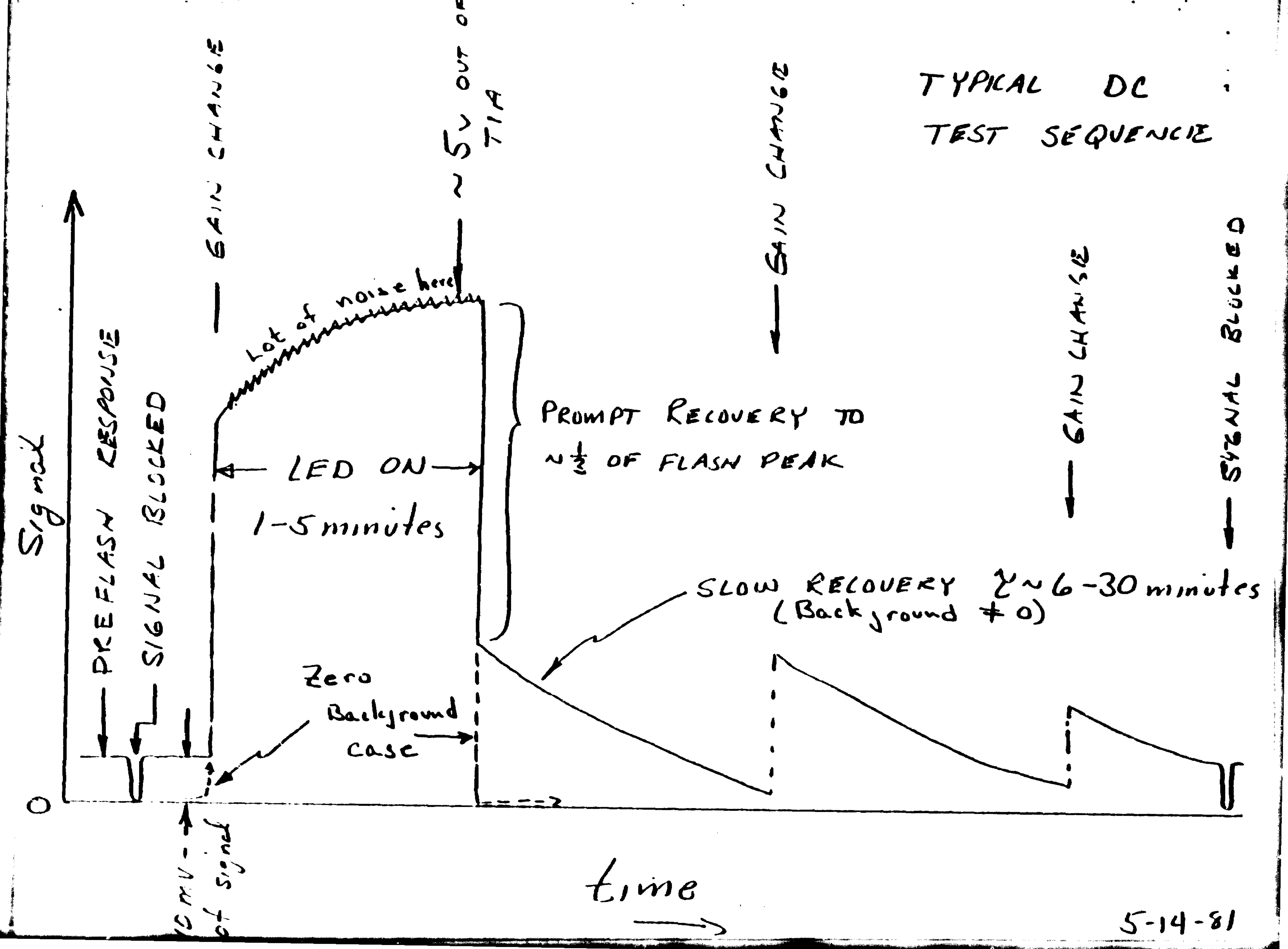
Conclusions:

(1) LED-induced-enhanced responsivity shows the same characteristics as γ-induced responsivity.

(2) Under low-background, low-temperature conditions the recovery time is very long, $\sim$ hours.

(3) Speedy recovery can be achieved by driving the detector into avalanche breakdown by increasing the bias.


(NOTE: TIA SATURATES @ 7V)
BREAKDOWN RECOVERY TEST DC CASE
$R_L = 5E9$
$I_{LED} = 0.5\ mA$
DC OUTPUT OF TIA
SIGNAL →
0
5V
7V
7V
LED ON (1-5 min)
~0.1 → 2.0V
~10 mVDC
$V_B = 1.0$ for 1 minute
$V_B = 1.0$ for 1 minute
TIA SATURATES
ALMOST (within ~20%) recovered
GOOD recovery ± 8%



TYPICAL DC TEST SEQUENCE
Signal
0
PREFLASH RESPONSE
SIGNAL BLOCKED
GAIN CHANGE
~5v OUT OF TIA
Lot of noise here
LED ON
1-5 minutes
PROMPT RECOVERY TO ~½ OF FLASH PEAK
GAIN CHANGE
GAIN CHANGE
SIGNAL BLOCKED
SLOW RECOVERY τ~6-30 minutes (Background ≠ 0)
Zero Background case
time
5-14-81